COGENERATION OPTIMIZATION

Improvements to cogeneration systems can decrease operating costs and emissions, while increasing generation efficiency at wastewater treatment facilities.

Cogeneration is a common feature of many wastewater treatment plants. Used in the United States for decades, it has proven to be a dependable, efficient, and cost-effective method of power generation.

Anaerobic digester gas, a wastewater treatment by-product, is used in cogeneration engines and generators to produce electricity for plant use or for sale, as well as thermal energy for heating work space or digester tanks.

The economics of cogeneration are variable, since changes in plant operation will affect energy use over the 20-year life span of a typical cogeneration facility. That's why operators should evaluate their systems every year or two to assess cogeneration's economic benefits and identify new opportunities for additional savings.

FACTORS THAT INFLUENCE ECONOMICS

Many factors can influence the cost effectiveness of cogeneration, including:

- ***Anaerobic Digester Gas Production***

Efficient operation relies on gas production levels and wise use of any available gas storage capacity.

If anaerobic digester gas production falls, wastewater treatment plants can optimize the efficiency of their cogeneration units by operating them only during their local utility's peak periods, when operators would pay more for purchased energy. Natural gas can also be purchased to supplement the amount of anaerobic digester gas available or to blend the two gases to improve gas quality.

If anaerobic digester gas production increases, it may be possible to increase electricity and heat production, or perhaps to add additional cogeneration engines. Facilities can gain additional operational flexibility by increasing anaerobic digester gas storage capacity through such options as flexible digester covers.

- ***Electricity or Thermal Energy Use***

If on-site energy needs decrease, the economics of cogeneration change as well. Wastewater treatment plants may find themselves selling excess electricity to the local utility for less than it costs to produce, or venting unneeded thermal energy. If on-site energy needs rise, managers should examine the benefits of increasing capacity or changing the mix of cogeneration and purchased power.

- ***Technology Advancements***

Manufacturers constantly improve combustion technologies and auxiliary cogeneration equipment. Lean-burn technology, for example, allows some facilities to increase generation capacity while staying within legal emission limits. These advances can change the economics of cogeneration. By checking with vendors periodically, managers can keep informed about technological improvements and new implementation strategies that will help them manage their facilities more effectively.

- ***Regulatory Requirements***

Air permitting requirements often change, typically by reducing allowable emissions or by imposing best available control technology requirements. Emissions offsets or continuous emissions monitoring may be needed. Affected engines may require new air or fuel controls, conversion to lean-burn technology, or modified operating strategies. Permitting revisions should be examined to see what their effect will be on these areas.

- ***Alternative Electricity Buy-Sell Arrangements***

Electric utility deregulation has significantly changed the electricity market, allowing for new contractual arrangements and pricing structures. These will affect cogeneration strategies, since wastewater treatment plants may be able to buy less expensive electricity, sell excess power to other consumers, or wheel power to outlying facilities. By carefully researching recent changes, plant managers can reevaluate their role as energy users and producers and better understand the regulatory and economic impacts of the evolving market.

OPTIMIZING THE BENEFITS

Installing additional cogeneration engines or modifying existing ones can increase energy production, enabling wastewater treatment plants to purchase less electricity or to sell more off-site.

Simply shutting down engines when their operation is not economic can save money and improve overall effectiveness. Varying an engine's output to match changing loads also helps to eliminate inefficiencies. Selling electricity or thermal energy to third parties or using it at other district facilities are other ways to maximize the benefits of cogeneration. Finally, some treatment plants may benefit from contracting the operation or ownership of their cogeneration facility to a third party.

COST CONSIDERATIONS

Co-generation optimization studies can be done in-house or by qualified engineering consultants. Based on the scope of the evaluation and the complexity of the systems, such studies can cost from $5,000 to $50,000, not including design costs for recommended modifications. Because many strategies for optimizing cogeneration involve operational changes rather than equipment retrofits, implementation costs can be minimal.

More strict air permitting requirements potentially can add costs for modifying engines or operations. Adding air/fuel controllers at the prime mover may be relatively inexpensive, while converting existing power units to lean-burn technology can cost from $350 to $700 per kilowatt.

Using an alternate fuel when digester gas is unavailable will add to operating costs. Some facilities have found, however, that fueling generator engines solely with purchased natural gas can still be economically beneficial.

DEMONSTRATED SUCCESS

Staff at the Encina Water Pollution Control Facility recently optimized their 14-year-old cogeneration plant, which consists of three 475-kilowatt engine generators and two 10,500 cubic feet per minute engine-driven aeration blowers. Previously, only three engines could be run at a time due to air quality restrictions. The facility converted three engines to lean-burn technology and upgraded the anaerobic digester gas management system to improve gas quality. These changes improved combustion efficiency and reduced emissions of SOx and CO, so that all five engines can now be run. All anaerobic digester gas is now utilized, and the plant provides 80 to 90% of the treatment plant's electrical requirements. The improvements cost $1.5 million and resulted in annual savings of $330,000 per year, offering a rate of return of 23%.

REFERENCES

Electric Power Research Institute, *Energy Audit Manual for Water/Wastewater Facilities*, Report CR-104300, July 1994.

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